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Endnotes

[1] A complete review of these products can be found in the Internet document, "How Do I Use the Internet as a Telephone FAQS" by Andrew Sears and Kevin Savetz at http://rpcp.mit.edu/~itel/voice_faq.html

[2] Pulver, Jeff. "Iphone vs. Digiphone." *Netwatch,* Oct. 30, 1995. URL: http://pulver.com/netwatch/research.html

[3] From an interview with Marc Andreesen of Netscape with the Sydney *Morning Herald* on March 13.

[4] This qualitative assessment comes from extensive testing of several applications by Andrew Sears.

[5] The sound quality is considerably worse than telephone calls, but in many cases the sound quality is tolerable, meaning that a conversation can be carried although audio will be lost on occasion when packets are dropped. From repeated personal testing by Andrew Sears of various applications, if at least a 28.8 kbps modem is used, one can expect to receive tolerable calls for roughly 90% of domestic calls in the US and roughly 50% of international calls.

[6] From IDT press release, "IDT TO UNVEIL NET2PHONE AT COMDEX," http://www.ios.com/new/net2phone.html

[7] Sears, Andrew. "The Effect of Internet Telephony on the Long Distance Market." Working Paper. Jan., 1996.

[8] Telephone interview with Guy Sederski, President of ACTA Board of Directors, 3/19/96

[9] Huber, Peter. *The Geodesic Network II.* The Geodesic Company, 1992.

[10] Huber. pp. 3.29

[11] Lee, Yvonne L. "Multimedia Carriers Split over Phonelike Internet Use." *InfoWorld.* Mar. 18, 1996. http://www.infoworld.com/archives/html/dt_IWE12-96_14.htm

[12] Commonly used figures are that T1 capacity produces a savings of a factor of 5 or more and T3 produces a savings of a factor of 10 to 20

[13] This conclusion comes from an interview with Jerry Hausman, a leading analyst of the telecommunications industry.

[14] A full discussion on Betrand price competition can be found in Pindyck and Rubinfeld's *Microeconomics.* pp. 428-429.

[15] Current T3 rates produce an overall line savings of a factor of 10-20.

[16] GSM compression is the most commonly used, which produces a bandwidth savings of a factor of 5, while Televox uses a compression routine that can produce a bandwidth savings of a factor of 53, but produces inferior sound quality.

[17] The POTS network uses circuit switching which requires 64 kilobits per second (kbps), regardless of whether someone is speaking through the line or not. Packet switching on the other hand allows everyone to share the same channel, so that when one person is not speaking, others may use the available bandwidth.

[18] The value of this additional bandwidth is complicated by the fact that many parts of the telephone network have excess bandwidth, so adding to that excess has little value. One argument against this is that not all parts of the network will have excess bandwidth, so this value added will exist over many parts of the network. The second argument is that if the market for long distance calling were competitive, there would not be such an excess of bandwidth, so the efficiencies of Internet telephony would always represent value added in a competitive market.

[19] Sears, Andrew. "The Effect of Internet Telephony on the Long Distance Market."

[20] Section 3 of the new "Telecommunications Act of 1996," Pub. L. No. 104-104, 110 Stat. 56 (1996), to be codified at 47 U.S.C. Section 153, includes the following definitions: (48) Telecommunications.--The term "telecommunications" means the transmission, between or among points specified by the user, of information of the user's choosing, without change in the form or content of the information as sent and received.
(49) Telecommunications Carrier.-- The term "telecommunications carrier" means any provider of telecommunications services, except that such term does not include aggregators of telecommunications services (as defined in section 226). A telecommunications carrier shall be treated as a common carrier under this Act only to the extent that it is engaged in providing telecommunications services, except that the Commission shall determine whether the provision of fixed and mobile satellite service shall be treated as common carriage.
(51) Telecommunications Service.- The term "telecommunications service" means the offering of telecommunications for a fee directly to the public, or to such classes of users as to be effectively available directly to the public, regardless of the facilities used.

[21] From the Telecommunications Act of 1996: "The term 'access software provider' means a provider of software (including client or server software), or enabling tools that do any one or more of the following: '(A) filter, screen, allow, or disallow content;'(B) pick, choose, analyze, or digest content; or '(C) transmit, receive, display, forward, cache, search, subset, organize, reorganize, or translate content."

[22] Internet telephony applications are currently being made available by companies in countries across the world, which the FCC cannot regulate. In fact, VocalTec, which probably currently has the largest market share in Internet telephony is an Israeli company. If the FCC were to ban the sale of Internet telephony software in the US, VocalTec could simply close its offices in the US and take US jobs and tax revenues to Israel where it could sell its Internet telephony software from Israel.

[23] This figure was obtained from an interview with Jerry Hausman. This figure may now be different because it is changed periodically.

[24] In fact at a recent presentation at Harvard, the Chairman of the FCC, Reed Hundt argued that the short term marginal cost of placing these calls is basically zero.

[25] "Federal Perspectives on Access Charge Reform: A Staff Analysis." FCC Access Reform Task Force. Jill Metlzer, Ruth Milkman, et al.

[26] "Federal Perspectives on Access Charge Reform: A Staff Analysis." FCC Access Reform Task Force. Jill Metlzer, Ruth Milkman, et al.

[27] One distinction is that most Internet telephony applications use the UDP protocol, while many other applications use the TCP protocol. The problem with banning the UDP protocol, is that it is required for many services other than Internet telephony, and is involved in very basic functions such as establishing connections. If it were banned then most existing applications would not function.

[28] This comes from an interview with John Walker, the developer of Speak Freely, and past CEO of Autodesk

[29] This estimate of derived from a market report of the Maloff Company, which showed that the IAP market was $47.6 million in March 1993 and $1.8 million in March 1994. Assuming the same exponential growth of 250% per year for the following years, a market size of $740 million is reached.

[30] Quote taken by Andrew Sears who was in attendance at lecture.

[31] Hausman. "Proliferation of Networks..."

[32] "The Unpredictable Certainty: Information Infrastructure Through 2000." NII 2000 Steering Committee, National Research Council. National Academy Press Washington, D.C. 1996.

[33] For more information see their homepage at http://www.pulver.com/fwd/

[34] From discussions with John Wroclawski and David Clark of MIT who are involved in RSVP development.

[35] This comes from Andrew Sears, one of the authors, who is involved in a research project at MIT to use Internet telephony to provide interoperability between the Internet and the PSTN.

[36] Katz, Rosston and Anspacher. "Interconnecting Interoperable Systems: The Regulators Perspective." *Information Infrastructure and Policy*, 1995. pp. 327-342.

[37] Utterback, James. "Mastering the Dynamics of Innovation." HBS Press, 1994. Ch. 3 & 4.

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